ALPHANUMERIC DOT MATRIX LCD MODULE
LM016, LM032, LM017, LM018
2lines series

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DESCRIPTION

The LM016, LM032, LM017, LM018 are a new line of dot matrix liquid crystal display modules from Hitachi. These modules utilize 5 x 7 dot matrix characters to provide alphanumeric capability with cursor. All control, refresh, and display functions are executed by a dedicated on-board control LSI. All LCD modules are capable of displaying the full 160-character JIS font set plus 32-character special font ts under user software control. The displayed characters are easily readable and gave a contrast ratio that improves as ambient light is increased. Data interfacing is via an 8-bit bidirectional data bus or a 4-bit one. By use of simple control commands, data can be selectively written to (or read from) any cursor location, arbitrary fonts can be written to CHARACTER GENERATOR RAM the mode of display function can be determined and so on.

FEATURES

- 5 x 7 dot matrix with cursor
- ±5V power supply
- On-board control LSI (HD44780)
- Powerful control commands
    Display clear
    Cursor home
    Display shift
    Display data read/write etc.
- 8 bit or 4 bit MPU interface
- Exceptionally low power consumption
- Extremely compact and light weight

APPLICATIONS

Hitachi alphanumeric displays can be used in a wide variety of applications including (but not limited to):
- Portable data terminals
- Word processors
- Text editing devices
- Office computers
- Process controllers
- Hand held computers
- Tele-communication equipment
- Automated scales and labeling equipment
- TTY terminals for the handicapped person

ABSOLUTE MAXIMUM RATINGS

Item	Symbol	min.	max.	Unit
Power supply for logic	$V_{DD} - V_{SS}$	0	7.0	V
Power supply for LCD drive	$V_{DD} - V_O$	0	13.5	V
Input Voltage	V_i	V_{SS}	V_{DD}	V
Static electricity	—	—	100	V
Operating temperature	T_a	0	50	°C
Storage temperature	T_{stg}	−20	70	°C

ELECTRIC CHARACTERISTICS T_a=25°C, V_{DD}=5.0V ±0.25V

Item	Symbol	Condition		min.	typ.	max.	Unit
Input "high" voltage	V_{iH}	—		2.2	—	—	V
Input "low" voltage	V_{iL}	—		—	—	0.6	V
Output "high" voltage	V_{oH}	$-I_{oH}$ = 0.2mA		2.4	—	—	V
Output "low" voltage	V_{oL}	I_{oL}= 1.2mA		—	—	0.4	V
Power supply current	I_{DD}	V_{DD} = 5.0V		—	0.5	3.0	mA
Power supply for LCD drive (Recommended)	$V_{DD} - V_O$	Duty=1/16	T_a = 0°C	—	5.4	—	V
			T_a = 25°C	—	4.8	—	V
			T_a = 50°C	—	4.0	—	V

Notes: The information contained herein is tentative and may be changed without prior notice. It is therefore advisable to contact Hitachi before processing with the design of equipment in corporating this product.

TIMING CHARACTERISTICS

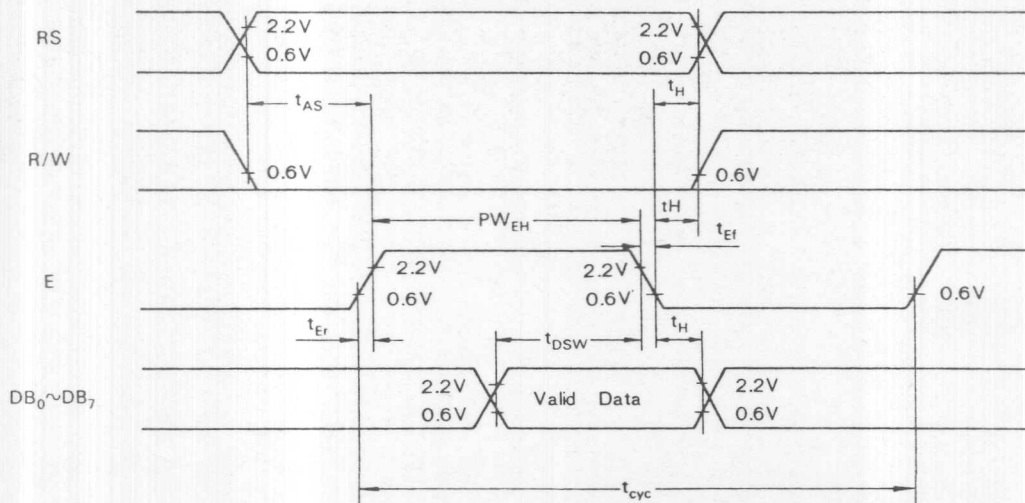| Item	Symbol	Test Condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 1, Fig. 2	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 1, Fig. 2	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 1, Fig. 2	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 1, Fig. 2	140	—	—	ns
Data delay time	t_{DDR}	Fig. 2	—	—	320	ns
Data set up time	t_{DSW}	Fig. 1	225	—	—	ns
Hold time	t_H	Fig. 1, Fig. 2	10	—	—	ns

Write Operation

Fig. 1 Interface timing (data write)

Read Operation
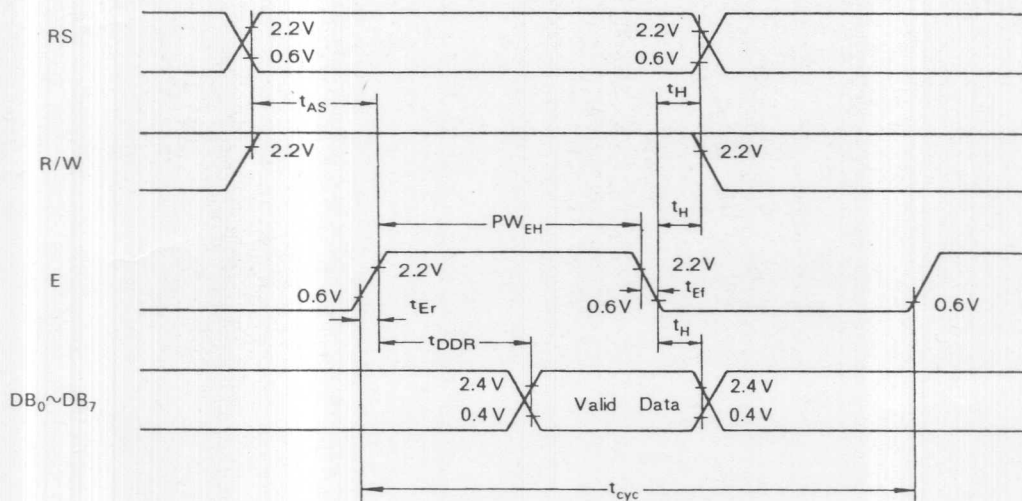
Fig. 2 Interface timing (data read)

OPTICAL CHARACTERISTICS

Item	Symbol	Condition	min.	typ.	max.	Unit	Note
Viewing area	$\phi 2 - \phi 1$	K = 1.4	20	—	—	deg.	1, 2
Contrast ratio	K	$\phi = 25°$ $\theta = 0°$	—	3	—	—	3
Response time (rise)	t_r	$\phi = 25°$	—	150	250	ms	4
Response time (fall)	t_f	$\phi = 25°$	—	150	250	ms	4

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Note 1. Definition of θ and ϕ

$y\,(\theta = 180°)$

x x'

$y\,(\theta = 0°)$
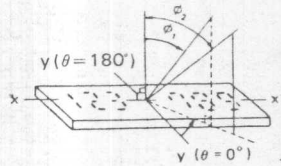
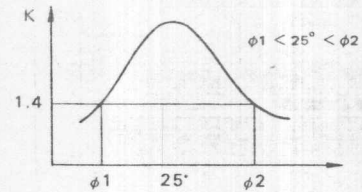**Note 3.** Definition of contrast "K"

$$K = \frac{\text{Brightness on non-selected segment } (B_2)}{\text{Brightness on selected segment } (B_1)}$$

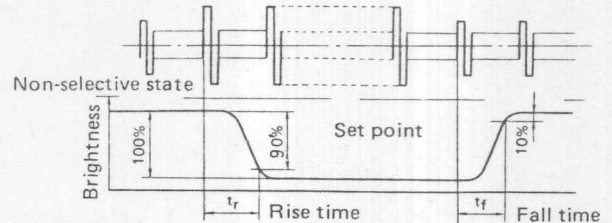Brightness curve on selected segment

Brightness curve on non-selected segment

Brightness (%)

Setpoint driving voltage
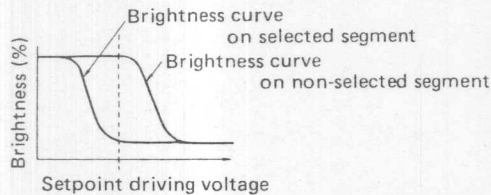
Note 2. Definition of viewing angle $\phi 1$, and $\phi 2$

$\phi 1 < 25° < \phi 2$

1.4

$\phi 1$ $25°$ $\phi 2$

Contrast ratio K vs viewing angle ϕ

Note 4. Definition of optical response

Non-selective state

Brightness

100%   90%   Set point   10%

t_r Rise time t_f Fall time

TYPICAL POWER SUPPLY FOR LCD MODULE

LCD Module

V_{DD} (+5V)

LCD Driving voltage $V_{DD} \cdot V_0$

V_0 VR V_{CC} V_{EE}

V_{SS} (−5V)

VR : 10KΩ ~ 20KΩ
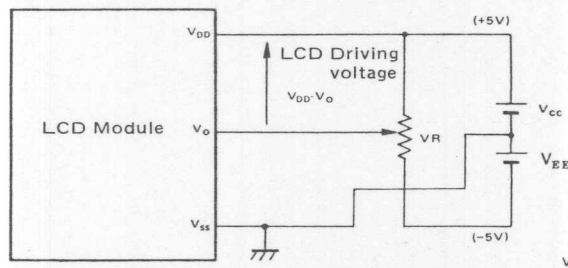
DETAILED DRAWING OF MATRIX PATTERN

Dimensions in mm

D
A
0.05
a
0.05
b
B
C
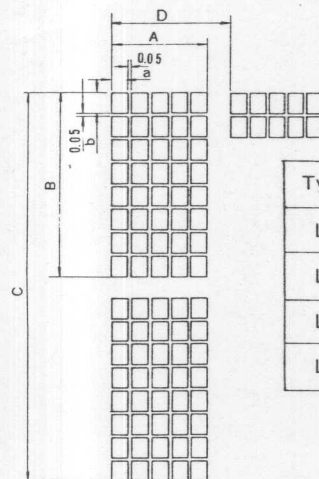
Type No.	a	b	A	B	C	D
LM016	0.55	0.65	2.95	5.55	11.5	3.55
LM032	0.6	0.65	3.2	5.55	11.5	3.7
LM017	0.65	0.65	3.45	5.55	11.75	4.2
LM018	0.6	0.65	3.2	5.55	11.5	3.7

PRECAUTIONS IN DESIGN

1. Mounting method

Since these modules are so constructed as to be fixed by utilizing fitting holes in the printed circuit board as shown below, it is necessary to take consideration the following items on attachment to a frame.

Protective plate
Fitting plate
Spacer
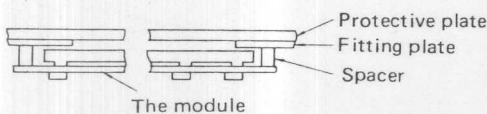
The module

Example of mounting

(1) Use of a protective plate, made of an acrylic plate, etc. in order to protect a polarizer and LCD cell.
(2) To prevent the module cover from being pressed, the spacers between the module and the fitting plates should be longer than 5.5 in mm. Also to avoid undesirable stress on the LCD keep tolerance of spacer height to ±0.1mm.

2. LC driving voltage (V_0) and viewing angle range

Adjust V_0 to obtain the best contrast.

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INTERFACE PIN CONNECTION

| Pin No.	Symbol	Level	Function	
1	V_{SS}	—	OV (GND)	
2	V_{DD}	—	+5V	Power supply
3	V_O	—	—	
4	RS	H/L	L : Instruction code input H : Data input	
5	R/W	H/L	H : Data read (LCD module → MPU) L : Data write (LCD module ← MPU)	
6	E	H, H → L	Enable signal	
7	DB_0	H/L		
8	DB_1	H/L		
9	DB_2	H/L		
10	DB_3	H/L	Data bus line Note (1), Note (†)	
11	DB_4	H/L		
12	DB_5	H/L		
13	DB_6	H/L		
14	DB_7	H/L		

Notes: In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1 operation so that it can interface to both 4 and 8 bit MPU's.

(1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$ and $DB_0 \sim DB_3$ are not used. Data transfer between HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$ when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$ when interface data is 8 bits long).

(2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

DIMENSIONAL OUTLINE

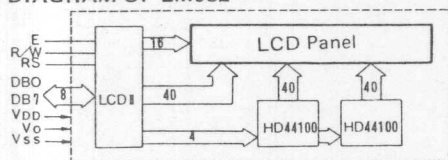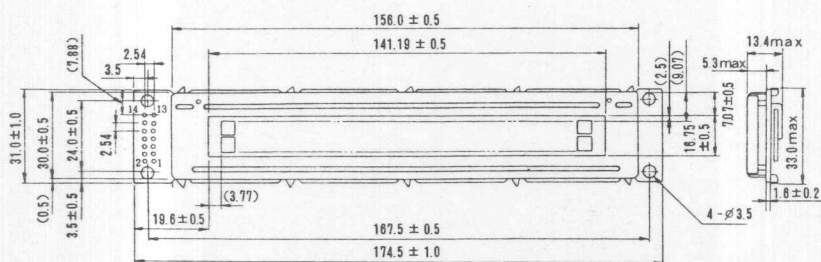| Item \ Type No.	LM016	LM032	LM017	LM018
Number of display characters	16 x 2 lines with cursor	20 x 2 lines with cursor	32 x 2 lines with cursor	40 x 2 lines with cursor
Module size (mm) width x height x thickness	84 x 44 x 15 max.	116 x 39 max. x 15 max.	174.5 x 33 max. x 13.4 max.	182 x 33.5 max. x 13 max.
Effective display area width x height (mm)	61 x 15.8	83 x 18.6	141.19 x 16.75	154.4 x 15.3
Weight (g)	25	50	60	65

LM016
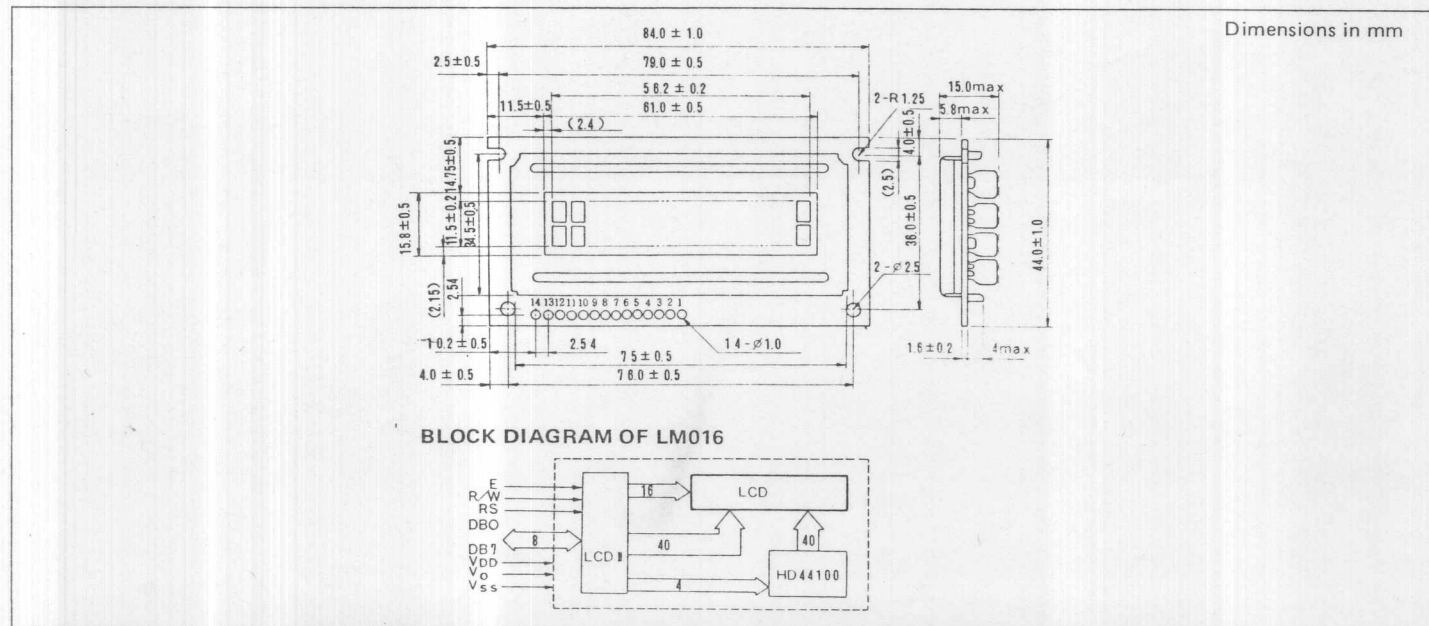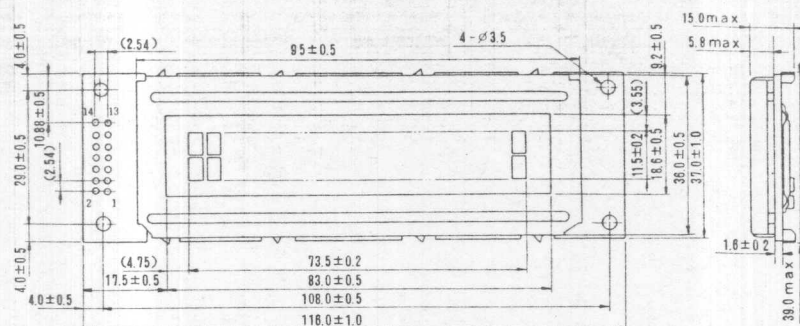
Dimensions in mm

BLOCK DIAGRAM OF LM016

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LM032

BLOCK DIAGRAM OF LM032

LM017

BLOCK DIAGRAM OF LM017

LM018

BLOCK DIAGRAM OF LM018

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Instruction	Code										Description	Execution time (when fcp or fosc is 250 KHz
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear display	0	0	0	0	0	0	0	0	0	1	Clears all display and returns the cursor to the home position (Address 0).	82 μs~1.64 ms
Return home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (Address 0). Also returns the display being shifted to the original position. DD RAM contents remain unchanged.	40 μs~1.6 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and specifies or not to shift the display. These operations are performed during data write and read.	40 μs
Display ON/OFF control	0	0	0	0	0	0	1	D	C	B	Sets ON/OFF of all display (D), cusor ON/OFF (C), and blink of cursor position character (B).	40 μs
Cursor display shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing DD RAM contents	40 μs
Function set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL) number of display lines (L) and character font (F).	40 μs
Set CG RAM address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data is sent and received after this setting.	40 μs
Set DD RAM address	0	0	1	A_{DD}							Sets the DD RAM address. DD RAM data is sent and received after this setting.	40 μs
Read busy flag & address	0	1	BF	AC							Reads Busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 μs
Write data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	40 μs
Read data to CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	40 μs

I/D = 1: Increment   I/D = 0: Decrement

S   = 1: Accompanies display shift.

S/C= 1: Display shift   S/C =0: Cursor move

R/L=1: Shift to the right.

R/L=0: Shift to the left.

DL = 1: 8 bits   DL = 0: 4 bits

N = 1: 2 lines   N = 0: 1 line

F = 1: 5 x 10 dots   F = 0: 5 x 7 dots

BF = 1: Internally operating

BF = 0 :Can accept instruction

DD RAM: Display data RAM

CG RAM: Character generator RAM

A_{CG}:   CG RAM address

A_{DD}:   DD RAM address

     Corresponds to cursor address.

AC: Address counter used for both of DD and CG RAM address.

Execution time changes when frequency changes. (Example) When fcp or fosc is 270 kHz:

$$40\mu s \times \frac{250}{270} = 37\mu s$$

"Dont' care

For details, refer to "HITACHI MICROCOMPUTER SYSTEM: DOT MATRIX LIQUID CRYSTAL DISPLAY CONTROLLER & DRIVER LCD-II (HD44780) USER'S MANUAL".

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Higher 4bit / Lower 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
××××0000	CG RAM (1)		P	`	p			―	タ	ミ		ρ
××××0001	(2)	!	1	A	Q	a	q	。	ア	チ	ム	ä	q
××××0010	(3)	"	2	B	R	b	r	「	イ	ツ	メ	β	θ
××××0011	(4)	#	3	C	S	c	s	、	ウ	テ	モ	ε	∞
××××0100	(5)	$	4	D	T	d	t	、	エ	ト	ヤ	μ	Ω
××××0101	(6)	%	5	E	U	e	u	・	オ	ナ	ユ	σ	Ü
××××0110	(7)	&	6	F	V	f	v	ヲ	カ	ニ	ヨ	ρ	Σ
××××0111	(8)	'	7	G	W	g	w	ア	キ	ヌ	ラ	g	π
××××1000	(1)	(	8	H	X	h	x	イ	ク	ネ	リ	√	x̄
××××1001	(2)	)	9	I	Y	i	y	ウ	ケ	ノ	ル	˙	y
××××1010	(3)	*	:	J	Z	j	z	エ	コ	ハ	レ	j	千
××××1011	(4)	+	;	K	[	k	{	オ	サ	ヒ	ロ	×	万
××××1100	(5)	,	<	L	¥	l	|	ャ	シ	フ	ワ	¢	円
××××1101	(6)	―	=	M	]	m	}	ュ	ス	ヘ	ン	±	÷
××××1110	(7)	.	>	N	^	n	→	ョ	セ	ホ	゛	ñ	
××××1111	(8)	/	?	O	_	o	←	ッ	ソ	マ	゜	ö	█

Note: CGRAM is a CHARACTER GENERATOR RAM having a storage function of character pattern which enable to change freely by users program.